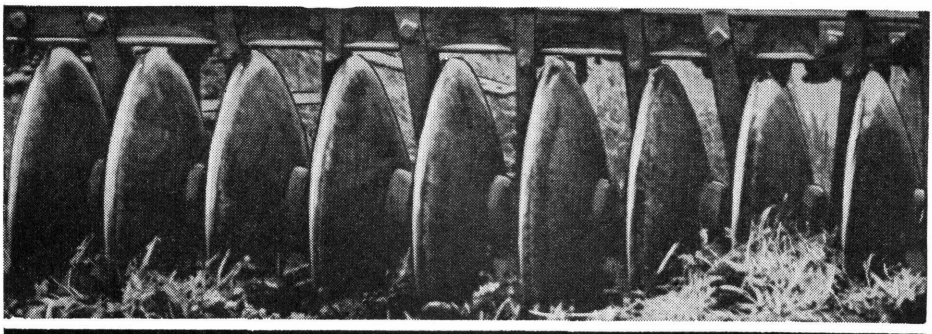
Farmers' Bulletin No. 1992

DISK PLOWS and their Operation



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DEPARTMENT OF AGRICULTURE

DISK plows have long been in use on soils too hard, sticky, or stony and on land too stumpy to be worked satisfactorily by the moldboard plow.

Changes in design, in line with improved soil-management practices, have enabled farmers to use disk plows increasingly. They are particularly useful in preparing seedbeds, turning under cover crops and surface debris, and controlling soil erosion.

Based on scientific research in its field, this bulletin should enable farmers to get the most out of their plowing equipment.

Washington, D. C. Issued May 1948

DISK PLOWS AND THEIR OPERATION

By I. F. REED, *senior agricultural engineer, Division of Farm Power and Machinery, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration* [1]

Contents

THE disk plow is especially popular on farms where the soil is hard and dry, sticky, or stony, or the land is stumpy. It is made in two types—the standard and the vertical. The primary soil-working part in both is a concave disk blade 18 to 32 inches or more in diameter.

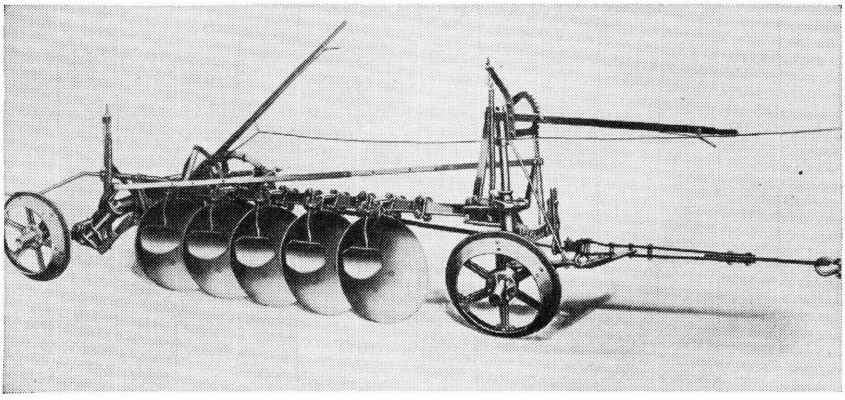

Figure 1.—Standard disk plow.

The standard disk plow (fig. 1) usually has one to six disks. Each blade has its own bearing mounting and is slanted at an angle with the vertical. This angle on some plows can be adjusted for different soil conditions.

The vertical disk plow (fig. 2), called by various manufacturers one-way disk plow, disk tiller, harrow plow, wheatland plow, or cylinder plow, differs from the standard in that a series of disks are spaced a fixed distance apart on a common axle or gang bolt. The axle with the vertical disks rotates as a unit and at an angle of 35° to

[1] This bulletin is based on material prepared jointly by R. M. Merrill, E. D. Gordon, formerly of the Bureau, and the author.

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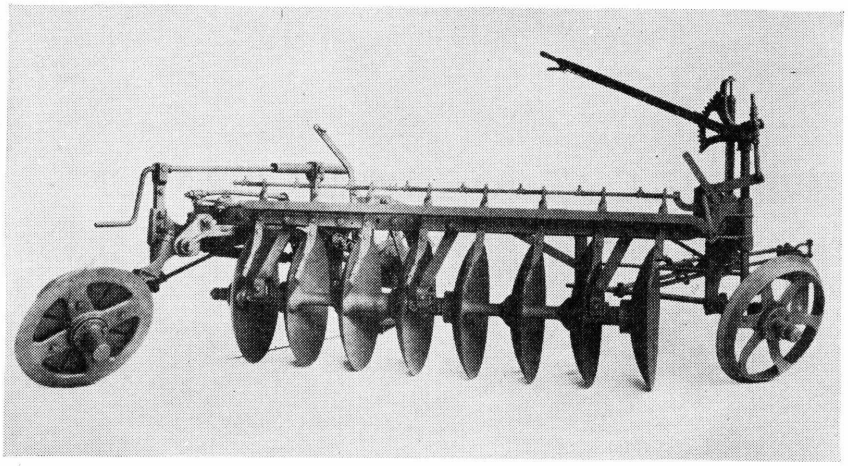


Figure 2.—Vertical disk plow.

50° with the line of travel. This plow first came into widespread use in the Great Plains about 1927.

COMPARISON OF DISK WITH MOLDBOARD PLOWS

A disk plow will do satisfactory work in certain soil conditions where a moldboard plow cannot be used effectively. It can be forced to penetrate soil that is too hard and dry for the moldboard plow and will also handle sticky soils in which a moldboard plow will not scour. Disk plows can be used in stumpy or stony land without so much danger of breakage. They will operate in loose soils, such as peat, without clogging and are more adaptable for deep plowing.

In very abrasive soils a disk plow will continue to operate, even after a considerable part of the disk is worn off, and long after a moldboard plowshare has lost its suction by wear. In these soils the cost of sharpening and replacing shares for moldboard plows is often prohibitive.

The disk plow, when properly adjusted and hitched, will operate under adverse conditions with less skilled attention than is needed for the moldboard. Disk-plow equipment, even when out of adjustment and carelessly used, will continue to operate fairly well under most conditions.

The disk plow does not turn over or pulverize the furrow slice as completely as does the moldboard plow and therefore does not cover surface trash and weeds so completely.

It leaves the soil in a rougher, more cloddy condition than does the moldboard plow and requires more conditioning operations to prepare the seedbed.

Since the penetration of a disk plow is effected by weight, rather than by suction as is the case with the moldboard plow, disk-plow equipment is much heavier than moldboard-plow equipment of equal capacity.

There is a common belief that disk plows are of lighter draft than moldboard plows, but many accurate tests have indicated that in soils where a moldboard plow works satisfactorily, its draft is lighter than that of a disk plow turning an equal amount of soil.

STANDARD DISK PLOW

Standard disk plows may be tractor- or horse-drawn. Most of this discussion, however, will apply specifically to tractor-operated plows, since they are the most numerous. General adjustment and operation features apply to both horse-drawn and tractor-drawn equipment.

The lighter tractor plows are adaptable, with slight changes in the hitch, as horse-drawn plows. Tractor disk plows may be of the trailing type, connected to the tractor with a flexible hitch, or of the direct-connected type, the front of the plow supported by the tractor.

The backbone of the standard disk-plow assembly is a stiff framework of steel sufficiently strong and well-braced to resist the twisting and bending imposed on the disks as they cut through the soil. To this rigid framework are attached the disk-blade assemblies, the hitch bar, and the wheel-bracket castings. Primary support for the plow frame of the trailing type is supplied by the two furrow wheels and the land wheel. Direct-connected disk plows (fig. 3) are so designed that the single furrow wheel and the attachment at the tractor serve to support and hold the plow.

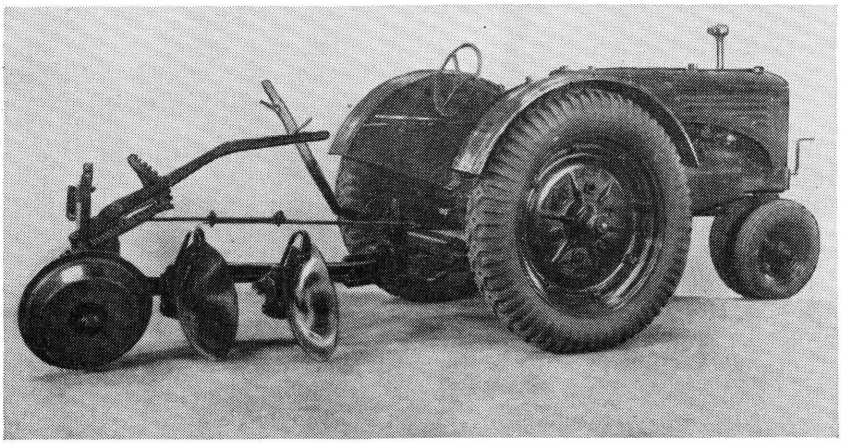


Figure 3.—**Direct-connected standard disk plow. A substantial back rest for the tractor seat would add to the comfort and safety of the driver.**

ADJUSTMENT AND OPERATION

Soil conditions vary so widely from one locality to another and within individual fields that it is impracticable to give detailed instructions to fit all cases of disk-plow operation. If the farmer understands the most important general adjustments, however, he can alter them to meet local conditions.

Most disk plows are flexible in operation, but the trailing type has more possible adjustments than the direct-connected tractor plow. On it, hitch height and width adjustment are made at the attaching points to the tractor. Details are given in the manufacturers' instruction manuals, although ordinary adjustments are made in the same way for both types.

The plow frame can be adjusted vertically and laterally by linkages, levers, and pivots. Angular adjustment of individual disk blades is provided for in a variety of ways. Wedges, specially arranged bolt holes in the plow framework, slotted corrugated clips, and hinged bearing mountings are used in various designs to change the tilt of the disk. In some plows wedges are also used in connection with the bearing bracket to change the disk angle, the angle the disk makes with the direction of travel. On most of them, however, the disk angle is adjusted by shifting the frame of the plow in relation to the wheels.

Disk spacing can be changed on several makes. In plowing at extreme depths larger diameter disks and greater clearances are needed. This may be made possible by increasing the spaces between disks, sometimes by removing one disk standard and relocating the rest.

The width of cut of the disk plow can be reduced or increased to adapt it to the power unit that pulls it. Most manufacturers make provision on certain models for the removal of one disk and sometimes two. After the disk or disks are removed the wheels, frame assembly, and connecting links are rearranged to accommodate those remaining. Diagrams in the manufacturers' instruction books show the proper procedure.

Weight is required to hold the plow to its work. If the soil is hard and dry, making penetration difficult, additional weight may have to be added. In loose soil it is sometimes necessary to use extension rims, or "sand bands," to keep the wheels from sinking too deep.

When a general-purpose tractor with adjustable tread is used with a disk plow, the tractor should be made as narrow as practicable so that its line of pull and the line of draft of the plow coincide as closely as possible. These adjustments may need changing slightly on trial. If the rear of the plow tends to swing out of the furrow toward the left the hitch on the tractor drawbar should be shifted to the right. Weights added to the rear furrow wheel will assist in holding the plow in its proper position.

For most conditions the rear furrow wheel should be set with a slight lead away from the furrow wall. The depth of plowing and the leveling of the plow are adjusted by hand levers or screws at the front and rear furrow wheels and the land wheel. The plow should run level, with all disks cutting the same depth. The land wheel should go straight forward, parallel to the line of travel.

Hitches

To adjust the horizontal hitch, first plow one round, with the rear disk cutting a good furrow. Stop with the front furrow wheel in the furrow regardless of the position of the tractor. Then unhitch the tractor and drive it into proper position in front of the plow. The tractor may be entirely on the unplowed land or may have one or two wheels in the furrow, depending on type of tractor and size of plow. For the smaller disk plows and the general-purpose tractors, the right rear tractor wheel is usually run in the furrow. When the tractor is in the desired position, adjust the hitch horizontally on the front of the plow (fig. 4*a*) to allow the front disk to cut its proper width. Then attach the plow hitch to the tractor drawbar and adjust the steering arm for the front furrow wheel of the plow (at *c*, in fig. 4), so that this furrow wheel is parallel to the furrow wall or has a slight lead to the plowed land.

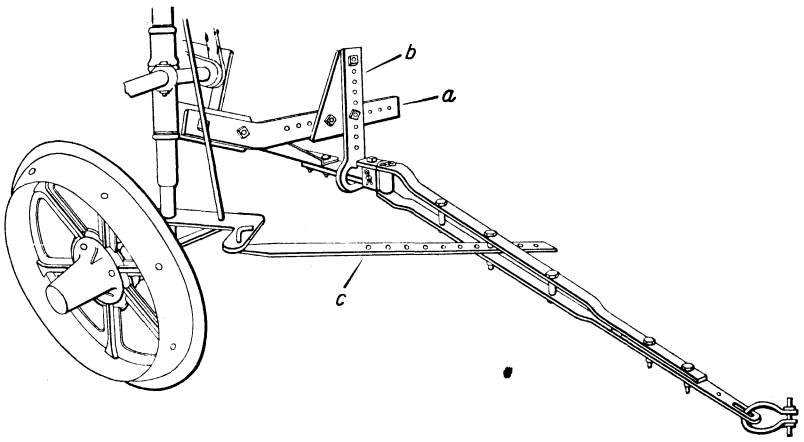


Figure 4.—Typical hitch arrangement on standard disk plow: *a*, Horizontal hitch; *b*, vertical hitch; *c*, steering arm.

The vertical-hitch adjustment on the plow (fig. 4, *b*) should be as low as the depth of plowing will permit. This will aid in holding the rear by putting pressure on the back wheels. For deep plowing or when the tractor drawbar is high, the vertical hitch should be raised to allow the plow to penetrate to the desired depth.

Disk Angle and Tilt

The disk angle, or the angle the face of the disk makes with the line of forward travel (fig. 5), can be regulated on most plows. This

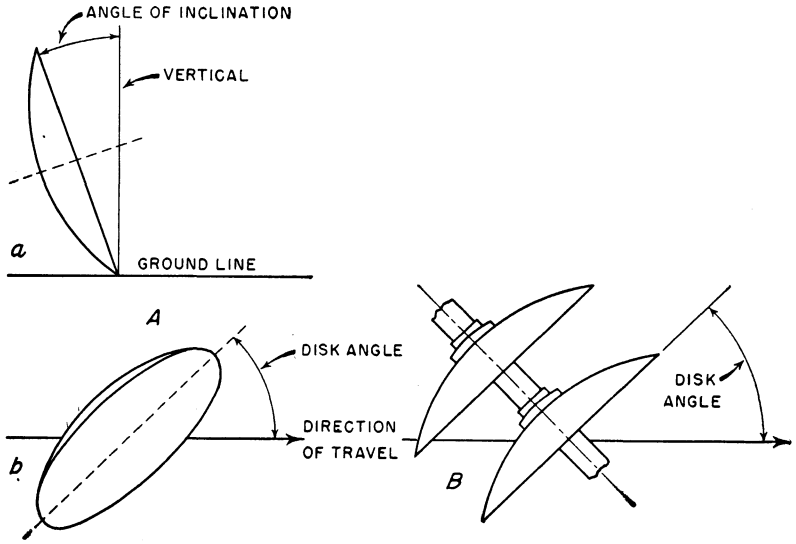


Figure 5.—*A*, Standard disk-plow blade, showing (*a*) tilt, or angle of inclination, from the vertical; (*b*) view from directly above, indicating disk angle in relation to direction of travel; *B*, vertical disk-plow blades, showing disk angle.

is usually done by changing the adjustment of the land-wheel bracket in relation to the plow frame. As the disk angle is increased, the width of cut of the gang is decreased; the smaller the angle, the greater is the width of the cut. The narrow cut at the greater disk angle is used in hard ground. Some plows have a wedge in the disk bearing mounting for adjusting the angle of each disk individually, leaving the total width of cut substantially the same.

The tilt of the disk (fig. 5) may be adjusted in various ways on different plows—by arrangement of holes for the bolts connecting the bearing standard to the frame, by use of wedges or eccentric washers in connection with the bearing support, or by a pivoted bearing support. The tilt should be increased for sticky, waxy soil and decreased for loose, sandy soil and in hard, dry soil. Decreasing the tilt puts the disk in a more nearly vertical position.

For extremely hard ground, where penetration is difficult, set the plow at its narrow width with the disks in their most nearly vertical position. If this does not give the depth desired, add weights to the plow.

DISK SCRAPERS

Scrapers with brackets are furnished as regular equipment with most standard disk plows. The three most common types (fig. 6) are the moldboard, or universal, the hoe, and the rotating. The brackets are designed to give a considerable range of adjustment for the scraper.

The moldboard scraper is used in soils that offer no scouring difficulties. Under these favorable conditions and with proper adjustment it assists greatly in covering trash and vegetation. Rotating and hoe scrapers are best in sticky soils where the moldboard type will not scour. Regardless of the type used, the scraping edge should be close to the disk face but with sufficient clearance to avoid friction in case the disk does not run true.

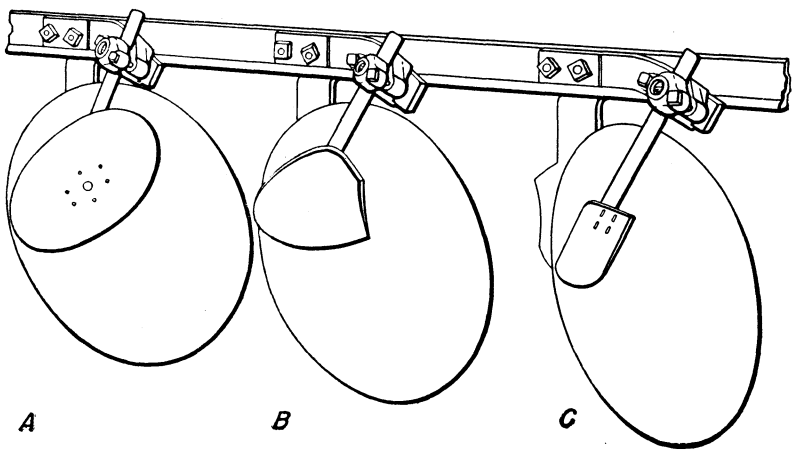


Figure 6.—Types of disk scrapers: *A,* Rotating; *B,* moldboard; C, hoe.

VERTICAL DISK PLOW

The general construction of the vertical disk plow (fig. 7) is somewhat similar to that of the standard except that the disks, instead of being independently mounted, are attached securely to a common axle or gang bolt with spacers between the individual blades. The entire unit is mounted in bearings on the main frame. Some of the larger plows use several gangs of disks, each on its gang bolt, and these are joined by couplings.

By means of hand levers or screws the disk gang of this plow can be raised or lowered with respect to the three wheels, thus providing means of depth control and of leveling the unit.

One of the most important construction features of the vertical disk plow is the provision made for absorbing the end thrust of the disk gang. The end thrust, which is heavy in this type of plow, is usually taken by a single antifriction thrust bearing or by a well-constructed plain thrust bearing. The radial load of the disk gang or gangs is supported on plain radial bearings.

The furrow wheels are usually of heavy construction with flanged rims to assist in holding the plow in operating position and in taking the side thrust. Most of these plows are equipped with a power lift operated by the land wheel or a hydraulic cylinder.

HITCHES

In order to hitch to the plow properly after making the first round of the field, place the tractor in position in front of the plow with its right rear wheel in the furrow or on the land, depending on the size of tractor, and the front furrow wheel of the plow in the furrow. Then adjust the horizontal hitch so that the front disk will cut its normal width. Adjust the steering arm of the front furrow wheel so that the

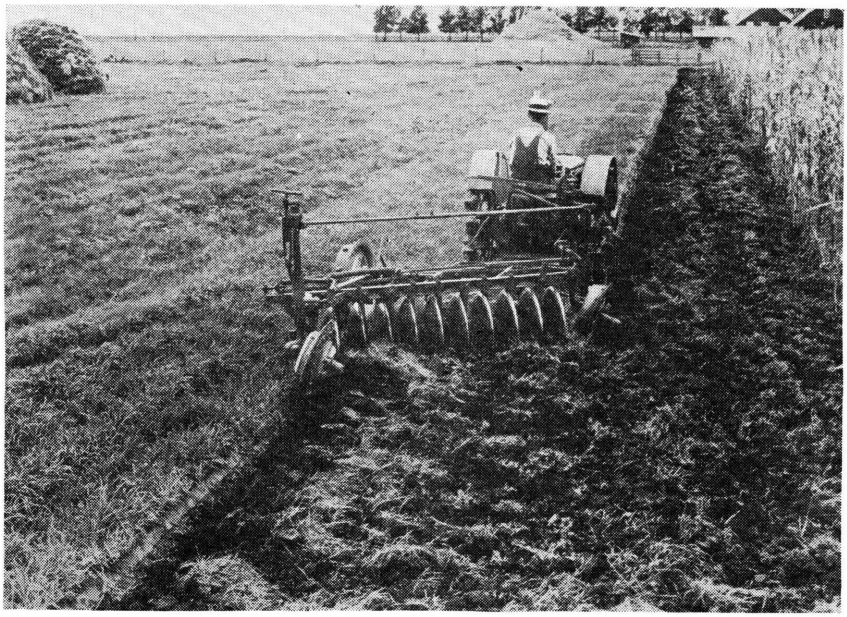


Figure 7.—Vertical disk plow in a field.

wheel has a slight lead toward the plowed ground. Then make the hitch to as near the center of the tractor drawbar as possible. This position will depend on the size of the plow and the width of the tractor. When properly adjusted, the front and rear furrow wheels of the plow should have a slight lead to the plowed ground, with the plow land wheel parallel to the furrow and the front disk cutting its normal width. If the rear wheel of the plow tends to climb out of the furrow and slew to the left, move the hitch on the tractor to the right and make the necessary changes in the adjustment of horizontal hitch and front furrow wheel to maintain the proper width of cut on the front disk.

The hitch on the plow should be kept as low as possible to hold the rear down. In deep plowing, however, it may be necessary to raise the hitch point to get penetration. Weights may then be needed, as the furrow wheel should always exert pressure on the ground. Most ot these plows have screws or levers for depth adjustment and leveling.

Many of the larger vertical disk plows are arranged in gangs in such way that a gang may be removed and the wheels, frame, and connections rearranged for the smaller plow.

The working angle of the gang is adjusted by shifting the land-wheel casting with respect to the main frame. The front and rear furrow wheels and hitch are then regulated to correspond with the land-wheel adjustment. The angle may range from 35° to 60°, with 40° to 45° about average for normal conditions. As with the standard disk plow, the disk angle should be increased for hard ground, though this reduces the total width of cut.

Scrapers and attaching brackets may be obtained for use with a vertical disk plow in wet and sticky soils. Trash guards also are furnished for some plows. Wheel weights can be obtained to give additional penetration.

CARE OF DISK-PLOW EQUIPMENT

Standard and vertical disk plows are sturdy, but they should have good care. To maintain proper alinement keep all nuts tight and promptly straighten or repair bent or broken braces, hitch parts, or levers.

Wheel bearings and the thrust bearing on a vertical disk plow must be kept well greased and properly adjusted when wear occurs. The radial bearings on the disk gang may or may not need lubrication. If they are replaceable and of maple wood the manufacturer usually recommends that they be not lubricated. A metal bearing should be greased or oiled.

The bearing of each individual disk of the standard disk plow must be kept in adjustment and well-greased whether it is of the plain or the antifriction type. These bearings should be disassembled at least once a season and thoroughly cleaned and the dust seals cleaned or, if necessary, replaced. Bearings should be lubricated at least twice a day when the plow is in use. All screw adjustments, axle sleeves, and other moving parts need to be oiled to permit ease of adjustment.

The disk blades must be kept sharp, ground on the same side as the original bevel. Rolling the blades to sharpen has not proved satisfactory for the heat-treated disks. When not in use, the disk blades should be coated with oil or grease.

DRAFT AND PENETRATION

The disk-plow operator can control several factors that influence draft and penetration. The draft of a disk plow varies from moderately low in sandy soils to a rather high figure in heavy clay soils. A sandy loam soil under dry and hard conditions, however, may require as much power for plowing as a clay soil under more favorable conditions.

A comparison of the drafts of a disk-plow blade in different types of soil is given in table 1. The soils in these tests were of average moisture content and not tightly packed.

Table 1.—*Disk-plow draft in sand, sandy loam, and clay soils*

[Disk diameter, 26 inches; depth of cut, 6 inches; width of cut, 9 inches; speed, 3.5 miles per hour]

Soil type	Moisture content of soil	Draft per square inch of furrow slice
	Percent	*Pounds*
Sand	5. 7– 5. 9	1. 9– 3. 0
Sandy loam	9. 3–10. 7	6. 3– 8. 5
Clay	14. 0–16. 0	9. 0–11. 3

Normal variations of speed of which mules or horses are capable in field work do not materially affect the draft or the depth of penetration of disk tools. The higher speeds of the tractor, however, especially when it is equipped with pneumatic tires, do affect them.

The draft of the disk and the side thrust increase rapidly with increases in speed of operation above that of horse- or mule-drawn equipment. Accurate tests under controlled conditions have shown that the draft of a single disk may double with an increase in speed from 2½ to 5 miles per hour.

Penetration in relation to speed appears to be affected by the tilt of the disk. If the disk is held in a vertical position, as would be the case in a vertical disk-plow unit, the penetration is decreased with increases in speed. When the disk blade is tilted, as it is in a standard disk-plow unit, the blade tends to penetrate many soils better at higher speeds. The tilt of the blade of many standard disk plows is adjustable.

Where there is considerable surface material to be plowed under and penetration is not difficult, a greater blade tilt turns the furrow slice better.

To avoid clogging, the disk should be set almost vertical. In heavy, sticky soils the blade will penetrate better if the tilt is increased. Most disk plows are designed to operate in a range from 15° to 25°, and in plows where the angle is not adjustable the setting is usually about 18° to 20°.

The present trend is to use disks of larger diameter. They take a wider cut, tend to cut through trash and surface debris better, penetrate the soil more easily, have less side thrust, and wear longer.

If the angle the disk makes with the line of travel is decreased to the point where the back side rubs on the furrow wall, the draft is increased and considerably more weight is required to hold it in the ground. As the angle is increased from this point to a maximum of about 45°, the disk blade penetrates better and the draft drops slightly. The draft increases with disk angles greater than 45°, especially in the heavier soils. The usual operating angle is about 42° to 45° for moderately deep concavity disks, and for greater concavity disks the angle is slightly greater than 45°.

In heavy, sticky soils it is necessary to use scrapers on the disks to avoid increasing the draft and having to add weight to keep the disk in the ground. Hoe-type and revolving-disk scrapers are more effective in very sticky soils. The moldboard-type scraper aids in doing a more thorough job of inverting surface trash and cover crops in soils that do not adhere to the scraper. The moldboard scraper tends to turn the furrow slice downward as it leaves the disk.

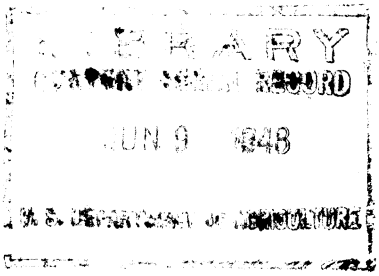
REMEMBER

Regardless of the care used in the design and construction of farm equipment, there are many points that cannot be completely safeguarded without interfering with accessibility and efficiency of operation.

A careful operator is the best insurance against an accident.

BE CAREFUL

1. Keep all shields in place.
2. Stop machine to adjust and oil.
3. When mechanism becomes clogged, disconnect power before cleaning.
4. Keep hands, feet, and clothing away from power-driven parts.
5. Keep off implement unless seat or platform is provided. Keep others off.



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